It is further urged that the disappearance in the long-tusked species of the flange on the lower jaw which protected the canines in the more primitive forms is correlated with this mode of opening the mouth, as the presence of such a flange would prevent the lower jaw lying close against the throat. Moreover, the anterior cheek-teeth, which are used by modern Carnivora chiefly for bone-crushing, and are most developed in the hyænas, have almost disappeared in the sabre-tooths, while, on the other hand, the shearing carnassial teeth—the sole function of which is flesh-cutting—have been inordinately increased in size and power.

As is well known, a large number of the mammalian contemporaries of the earlier sabre-tooths were short-necked and probably thick-skinned ungulates, some of which were more or less distantly allied to the modern tapirs and others to the pigs. And in the same manner as the long-necked and thin-skinned ruminants of to-day form a large portion of the prey of the modern lion, tiger, leopard, &c., so these early ungulates fell victims to the attack of the sabre-tooths. Now, antelope and deer are killed by the neck being bitten through or broken when attacked by the larger Carnivora; but it seems unlikely that such a method of attack would be successful in the case of short-necked and thick-skinned animals.

Accordingly, it is suggested by Mr. Matthew that in the case of the sabre-tooths "their most advantageous method of attack was to inflict stabbing and ripping cuts at points where an artery could be reached, using their short, broad and powerful fore-feet as fulcrums, and probably bleeding the animal to death."

It is added that the earlier appearance of true cats in Europe as compared with North America, where they are very rare throughout the Tertiary period, may very probably be correlated with the earlier appearance and greater abundance of the modern type of specialised ruminants in the Old World. Finally, the largest and most specialised member of the group, the great *Machaerodus neogaeus* of the Pleistocene of South America, which the author believes to have been the slowest mover of its kind, may have preyed on the huge thick-skinned and slow-moving ground-sloths which attained such a remarkable development in that continent. In a subsequent section the author hazards the suggestion that the more cat-like Carnivora known as Dinictis, the upper tusks of which were noticeably shorter than those of the sabre-tooths, were creatures with a greater turn of speed and therefore better adapted for preying on the smaller and swifter-footed Herbivora than was the case with their long-tusked relatives. R. L.

UNIVERSITIES IN RELATION TO RESEARCH.[1]

IT will perhaps be expedient for me at the outset to say that I propose to use the word research in its widest meaning, *i.e.* as indicating those efforts of the human mind which result in the extension of knowledge, whether such efforts are exerted in the field of literature, of science or of art.

The chief agencies of modern organised research are (1) the learned societies and (2) the universities. The former receive and publish research papers; the latter superintend and direct investigators and publish results. To these should properly be added the various journals which have been established and carried on by private effort. It is a significant fact that the establishment of modern learned societies coincides closely in time with the Renaissance movement. Telesio established one of the earliest mathematico-physical societies—the Academy of Cosenza. Other Italian societies of similar scope were founded in Rome in 1603, in Florence in 1657, and the Royal Society of London dates from 1660 or earlier. Organised research in universities was of slower growth. In them the mediæval spirit was tenacious of life, and it was only in the nineteenth century, in Germany, at the close of the Napoleonic wars, that research, not only in natural philosophy, but in the whole field of knowledge, became the basis of the German educational system, and I might remark, without going into details, that the university systems of France and the other principal countries of Europe, with the exception of Great Britain, are in the main parallel with that of Germany, although not so consistently elaborated.

We are so subject to the authority of words that it is difficult for us to realise that the organisation called a university in Germany is almost entirely different in scope and object from the institution which we so designate in this country. Hitherto, at least in England and Canada, the function of the university has mainly been to impart a general and liberal education, continuing and completing the beginning already made in the secondary school. Speaking generally, I may say that under the German system the work of our secondary schools and universities combined is performed by the gymnasium, the nine or ten years' training of which leaves the young man of nineteen or twenty years of age with a much better liberal education than that possessed by the average graduate in arts of an English, Canadian or American university. How this is accomplished it is not my purpose here to explain. There is no doubt, however, as to the fact, which is substantiated both by the nature of the curriculum of the gymnasium and by the testimony of those familiar with both systems.

It is upon this substantial preliminary training that the work of the German university proper is based. Up to this point the young man has been a "learner"; on entering the university he becomes a "student." This distinction, expressed by the German words "lernen" and "studieren," marks the difference between gymnasium and university—the acquisition of knowledge under the teacher in one, the independent research under the guidance of the professor in the other.

The ultimate object of both professors and students is the advancement of knowledge, and the independence with which research is conducted is well expressed by the two words "Lehrfreiheit" "Lernfreiheit"—the freedom of the professor as to what he teaches and the freedom of the student to select his special line of research. Some idea of the extent of this work may be formed from the number of universities in Germany, twenty-one in all, and from the fact that the aggregate number of matriculated students exceeds 12,000, in addition to non-matriculated students, who are also numbered by thousands, while the philosophical faculty at Berlin and Leipzig in 1901-2 numbered, respectively, 207 and 120. To the twenty-one universities mentioned should be added the nine technische Hochschulen which have now the right to confer the doctor's degree in the applied sciences.

The place and importance of research in the German system is further indicated by the fact that even teachers in the gymnasium devote themselves to such work, their papers being published in the annual reports of their institutions. With such respect is the ability for research regarded that the publication of a paper of this kind may lead directly to a professorship in the university, as was the case, for instance, in the appointment of Weierstrass, the celebrated mathematician.

In the organisation of the German university, research has been shown to be a fundamental principle; in the British university it is as yet incidental or of sporadic manifestation. I do not, of course, ignore the very important contributions which have been made by British scholars to the advancement of learning, but it is worthy of note that the credit for their splendid achievements is rather due to the individuals themselves than to the universities with which many of them were connected. The British university is not primarily an institution for research. In its function of providing the higher grades of a liberal education the proper comparison is with the upper classes of the German gymnasium, not with the German university proper. True, we find in some of the British universities a specialisation in certain subjects, *e.g.* in honour classics and mathematics at Oxford and Cambridge, leading to higher work than that attempted in the gymnasium; but however advanced the studies may be, there is rarely any attempt to guide the English undergraduate in the direction of research. Reading and examinations are the academic watchwords, and to the great mass of students and tutors the field of research is a *terra incognita*.

The attitude of the British nation has been hitherto largely that of indifference towards organised research, and this has been true, not only of the general public, but also of those engaged in academic administration. There has existed a deep-seated conviction, born perhaps of reiterated assertion, that the British university system is superior to that of Germany or any other country, and as near perfection as may well be. We are not concerned just here with the discussion of the merits of the system, which are undoubtedly many and great, but we must admit that the attitude of self-satisfaction which has prevailed, combined with the ignoring of other ideals, is at least unphilosophic. In the

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[1] Abridged from the presidential address delivered by Prof. James Loudon before the Royal Society of Canada at the recent annual meeting of the Society at Toronto.

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midst of such an atmosphere it is not surprising that the development of a true Renaissance spirit has been somewhat tardy.

But the British nation is on the eve of an awakening, an awakening which has already taken place among certain leaders of thought. The fact is dawning upon the British mind that some vital connection really does exist between national progress and scientific discovery, and that the latter should be fostered in connection with the higher institutions of learning. Under the conviction that British commercial supremacy will be seriously threatened unless foreign, and especially German, scientific methods are adopted, universities of a more modern type than Oxford and Cambridge, and also technical colleges, have been established. Such institutions no doubt fill a long-felt want, but they do not go to the root of the matter. On the academic side they are but a modification of the older type; on the technical side they contemplate, not the discovery of new truth, but the application of what is already known. The spirit of research is lacking, and without it no expenditure of money, no raising of examination standards for mere acquirement, will actually increase the capital account of national knowledge.

The policy of the universities of the United States regarding this matter is in marked contrast with the indecision and conservatism which prevail in the mother country. The type of mind which has been developed in the century and a quarter of separate national existence is one of great vigour and originality; but these qualities have for the most part been turned aside by the circumstances of a new country from abstract investigations. Research after the almighty dollar by the nearest short-cut has been, and perhaps still is, regarded as the chief national characteristic of our American cousins, and in this pursuit they have displayed a genius for concrete research in mechanical invention and an ability for commercial and industrial enterprise which have been an object of wonder, and latterly of anxiety, to other nations. During the first hundred years of national existence the university of the gymnasium type which had been inherited from England continued to develop and expand in the United States. Suddenly, however, almost exactly twenty-five years ago, a remarkable modification was introduced.

Since 1877 many universities, including the best of those already in operation, as well as new foundations, have added a graduate department leading to the Ph.D. degree, although none of these, with the exception of Clark University, has made the prosecution of research the sole business of the university. Some idea of the rapid progress of this movement may be gathered from the fact that the numbers pursuing graduate studies in the universities of the United States have increased from 8 in 1850 to 399 in 1875, and to about 6000 in 1902.

I have confined my remarks up to this point almost wholly to the historical aspect of the question, but it will perhaps not be out of place for me to point out in conclusion some of the advantages which in my opinion are connected with the pursuit of university research.

Let us consider first the stimulating effect upon the individuals and institutions concerned. Among those who are affected by this stimulus should first be named the professor. Dr. Samuel Johnson was wont to compare accumulated knowledge to a heap of ice lying exposed to the summer sun, the bulk of which could not be maintained without constant replenishment. Continuing the figure, we can readily imagine that the professor's fund of knowledge which is ample enough for the class-room teaching of immature minds might shrink and trickle away until little is left but the sawdust which we usually associate with the preservation of that commodity. Under the stimulus of research this is impossible, for research into the new implies a full and minute mastery of that branch of knowledge in which the research is being conducted. Hence if no other advantage resulted a good case might be made out along this line of argument.

This stimulus to the professor would react with increased force upon the student. It was a favourite saying of a certain celebrated artist that those who follow after others rarely outstrip them. To hold up before the student either by theory or practice solely the ideal of acquiring what has already been learned is mediævalism pure and simple; it is to teach him to creep where he might walk upright and alone; it is to rob him in part of that intellectual birthright of independent thought which is the inheritance of every man, at least since the Renaissance. It is sometimes objected that the results attained by research students are often trivial or futile. I am disposed, however, to agree with a remark made by one of George Eliot's characters:—"Failure after long perseverance is much grander (and I would say parenthetically more useful) than never to have a striving good enough to be called a failure." It is sometimes also urged that research in the immature student leads to superficiality and conceit. I cannot but think this fear ill-grounded. It has been proved, on the contrary, that nothing will so quickly ripen and enlarge preliminary knowledge and so effectually extinguish presumption as the hand-to-hand struggle with some special problem in the department of study in which the student is already proficient.

Apart from the professor and student, the first effect of the inauguration of research work in our universities, if of the genuine stamp, will be felt upon the teaching profession of the country as a whole. Assuming an educated and interested public opinion, the premium so long placed upon memorised knowledge will disappear, and a change in the principle of selection of teachers both in universities and secondary schools will result.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AFTER consultation with Mr. Astor, and in accordance with his wish, the council of University College, London, has resolved to endow the chair of pure mathematics and to name it the "Astor chair." The staff of the reorganised department of chemistry of the College will be as follows:—General and inorganic chemistry: professor, Sir William Ramsay, K.C.B., F.R.S.; assistant professors: Dr. F. G. Donnan, Dr. Morris Travers and Mr. E. C. C. Baly. Organic chemistry: professor, Dr. J. Norman Collie, F.R.S.; assistant professor, Dr. S. Smiles.

THE Royal Commissioners for the Exhibition of 1851 have made the following appointments to science research scholarships for the year 1902, on the recommendation of the authorities of the several universities and colleges:—University of Edinburgh, J. K. H. Inglis; University of Glasgow, A. Wood; University of St. Andrews, W. Wallace; University of Aberdeen, A. C. Michie; University of Birmingham, J. A. Lloyd; Yorkshire College, Leeds, H. D. Dakin; University College, Liverpool, F. Rogers; University College, London, E. P. Harrison; Owens College, Manchester, G. C. Simpson; Durham College of Science, Newcastle-on-Tyne, C. R. Dow; University College, Sheffield, G. B. Waterhouse; Queen's College, Galway, W. Goodwin; University of Toronto, W. C. Bray; Dalhousie College, Halifax, Nova Scotia, T. C. Hebb; University of Melbourne, R. Hosking; University of Adelaide, W. T. Cooke; University of New Zealand, M. A. Hunter. The following scholars nominated in 1901 have had their scholarships continued for a second year on receipt of a satisfactory report of work done during the first year:—F. Horton, A. Slator, R. B. Denison, G. Owen, G. Senter, F. W. Rixon, T. Baker, S. C. Laws, Alice E. Smith, J. Hawthorne, R. K. McClung, C. W. Dickson, G. Harker. The following scholars nominated in 1900 have had their scholarships exceptionally renewed for a third year:—Dr. W. M. Varley, Dr. S. Smiles, J. A. Cunningham, W. S. Mills, J. Patterson, J. Barnes.

THE Cambridge summer meeting organised by the Local Examinations and Lectures Syndicate was opened on Friday last with an address by the vice-chancellor, Dr. A. W. Ward, master of Peterhouse. Many men of distinction are taking part in the meeting, and the lectures cover a very wide range. The general subject of the meeting is "Some Aspects of Life and Thought in Europe and America in the Nineteenth Century." In the section of physical and natural sciences, the following lectures will be delivered during the meeting, which is divided into two parts, and ends on August 26:—"Some Modern Astronomical Speculations," Prof. G. H. Darwin, F.R.S.; "Sidereal Astronomy," Mr. Arthur Berry; "Meteorology in the Nineteenth Century," Dr. W. N. Shaw, F.R.S.; "Pasteur and his Work," Prof. Sims Woodhead; "An Aspect of the Influence of America on Geology," Dr. R. D. Roberts; "Progress of Geology in the Nineteenth Century as illustrated by modern views on (1) The Structure of the Earth's Crust, (2) The Evolution of the Configuration of the Surface," Mr. J. E. Marr, F.R.S.; "Advances of Botany," Prof. H. Marshall Ward, F.R.S.; "A Great Botanist: Sachs," Prof. W. B. Bottomley; "Colour Photography," Mr. T. B. Wood; "The Rise and Development of Electro-Chemistry," Mr. D. J. Carnegie. Among the subjects in the section of education are:—"Hygiene as a Factor in National Education," Miss A. Ravenhill; "Nature-Study" (Six Lectures), Prof. Patrick Geddes;

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